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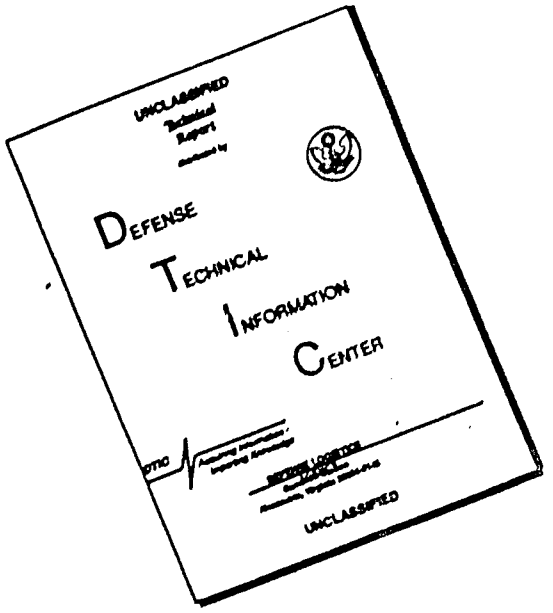

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ACTIVITY-SIZE RELATIONSHIP OF FALLOUT PARTICLES FROM TWO SHOTS, OPERATION REDWING

Research and Development Technical Report USNRDL-TR-314

19 February 1959

by

H.K. Chan

U.S. NAVAL RADIOLOGICAL DEFENSE LABORATORY

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Research and Development Technical Report USNRDL-TR-314
NS 081-001

19 February 1959

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H.K. Chan

Effects of Atomic Weapons

Technical Objective
AW-7

Radiological Effects Branch
T. Trifflet, Head

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ABSTRACT

The activity of coral fallout particles was studied as a function of individual size. Single particles from two shots at Operation REDWING were sized and identified as being of a spheroidal, irregular or dendrite-like type and then measured for gamma activity. Two particle size parameters were employed, equivalent projected area diameter (D_a) and maximum diameter (D_m). The study shows that an extensive range of activities is associated with each size and size-type group. Field data taken at one station indicate that the activities of a size-type group follow a normal distribution. According to the same data the activity varies as $D_a^{2.2}$ and $D_m^{1.7}$ for irregular particles, $D_a^{3.7}$ for spheriodal particles, and $D_m^{2.1}$ for dendrite-like particles.

NONTECHNICAL SUMMARY

The Problem

In order to predict the radiation hazards arising from fallout and devise protective countermeasures against them it is necessary to determine the characteristics of the fallout particles. Among the important characteristics needed is the relationship between two important individual aspects of fallout particles, size and radioactivity.

Previous studies have considered the total radioactivity associated with particles grouped according to size ranges. However, this approach does not consider the variation of radioactivity with particles of different shape, shape being an indication of the differences in the manner radioactivity is incorporated in the particle. Also, the methods used in past studies for separating the particles into size ranges did not prevent the break-up of some particles, of which the fragments were regarded as being smaller particles. These two conditions caused misleading results in the final data in attempts to quantitatively describe a relationship between the size and radioactivity of fallout particles.

The Findings

In this investigation, the shape, size, and level of radioactivity were determined for individual fallout particles. A wide range of radioactivity intensities was associated with each of the size groups and size-shape groups of particles. In the case of particles collected at one station in the field, a possibility was indicated that the radioactivity is normally distributed over a size-shape group. This set of data also indicate that regarding a relationship to particle shape, radioactivity varies approximately as the square of the diameter for irregular particles and as the 3.7 exponential power of the diameter for spheroidal particles. In the case of dendrite-like particles, the activity varies with a function exponentially greater than the irregular particle function.

ADMINISTRATIVE INFORMATION

The work reported is a direct outgrowth of Project 2.6.3, Operation REDWING. This project is described, as Problem 1, Program 2, in this laboratory's Preliminary Presentation of USNRDL Technical Program For FY 1957, dated February 1956. The work reported was done under Bureau of Ships Project No. NS-081-001, as part of Problem 1, Program 1, which is described in USNRDL Technical Program For Fiscal Year 1958. Progress of the general project of which the work is a part was most recently reported in Quarterly Progress Report, 1 October to 31 December 1958, Progress Report USNRDL-P-15, January 1958, wherein it is identified as Problem 7, Program A-1.

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CONTENTS

TABLES

FIGURES

INTRODUCTION

Relationships between the size and radioactivity of fallout particles play an important role in fallout phenomenology and model research. These relationships aid in the assessment of radiological situations and, more important, may reveal the manner in which activity is associated with the particles. Furthermore, the modes of association may provide some insight into the history of fallout material and suggest the mechanism of particle formation and contamination.

It has been generally hypothesized that activity is a function of either particle surface area or volume. Experimental data to confirm this hypothesis is needed. In the case of coral fallout particles, radioautographic studies by Adams[1-4] have shown the existence of three general types of particles with intrinsic differences in activity association. Irregularly shaped particles generally have the activity concentrated on the exterior, indicating that it was deposited after the particle was formed. Spheroidal particles usually have the activity dispersed throughout, suggesting that it was incorporated during some molten state. Regarding the third type, particles with a dendrite-like structure, little is known of activity association. The existence of such differences necessitates the consideration of particle shape in the activity-size relationships of coral particles.

Other studies[5,6] have been limited to the composite activity associated with size fraction. However, certain deficiencies are inherent in this method of study. The approach does not take into account the variability of particle activity due to particle type. Moreover, particle size separation was generally accomplished by sedimentation, sieving and other agitating methods; since a substantial portion of coral particles are dendrite-like and fragile, these methods very likely cause particle breakup and subsequent errors. Regarded as smaller particles, the fragments cause inaccuracies in the data, particularly fragments from particles with activity concentrated on the exterior. It is essential, therefore, to employ a method of study that will consider particle type and will not break up fragile particles.

Such requirements are met by the study of individual discrete particles.* This approach not only provides reliable data but also gives needed

* It is to be noted that Kikuchi, et al.,[7] examined a number of individual CASTLE particles, but neglected particle type; no correlation between size and activity was found.

information regarding the distribution of activity among particles of the same size. Such an approach was employed by Project 2.63[8] in experimental studies at Operation REDWING. During these investigations the activity-size relationships of individual coral fallout particles from two shots, designated as A and B, were studied.*

EXPERIMENTAL PROCEDURE

Experimental design was based on the collection and analysis of single discrete particles; consequently, preservation of individual characteristics was a fundamental collection requirement. Fallout particles were collected on a special sampling surface and the determinations of individual size, shape and gamma activity were undertaken. Procedures were also included to obtain some particle size distribution information, although another project[9] featured this as its primary objective.

Sampling Technique

Fallout particles were sampled by incremental collectors (IC), which are fully described in Reference 8. The collectors sequentially exposed 4 x 4-in. plastic sampling trays, each containing a cellulose acetate disc coated with a heavy layer of special grease; the actual sampling area was 8.2 cm in diameter. For each IC, the exposure period of its trays were identical and preset at either 3, 15 or 36 min, depending on the number of IC's at a station and the expected rates of fallout.

The particles studied were collected at major project sampling stations located on several vessels. For Shot A, only the collection from the YAG-40 was studied. For Shot B, the samples investigated were from YAG-40, YAG-39, LST-611, YFNB-13, and YFNB-29 (two stations). At all stations, project collectors - of which the IC was one type - were located on an elevated wind-shielded platform, designated as a standard platform. Detailed descriptions of the vessels, platforms and their instrumentation may be found in Reference 8. Except for the YAG-40 collections from both shots, the particles investigated were sampled by platform-mounted IC's and shipped back to NRDL for analysis.

In addition to its platform collectors, the YAG-40 had special collecting equipment and a shielded laboratory with facilities to take early-time measurements. Particles for the present study were collected by two adjacent, independently operated, modified IC's designated as special incremental collectors (SIC). These instruments were in a 6 x 3-1/2 x 6-ft housing

* Shot A is the first of the shots in which USNRDL participated during Project 2.63; Shot B is the fourth.

installed on the "flight" deck, which was situated on the ship's bow approximately 8 ft above the main deck. The SIC's were so mounted that their sampling ports were located together and exposed flush with the roof of the structure. To reduce wind bias effects, a horizontal steel plate was placed on top of the SIC housing to give an 18-in. overhang on the forward and lateral sides. The opening in the plate for the sampling ports was located forward of the plate center and the plate was greased to prevent those particles falling on the plate from blowing or rolling into the sampling port. Investigators located in the shielded laboratory below controlled the SIC sampling intervals and, immediately after exposure, the trays were lowered by an elevator into this laboratory where analytical procedures were begun.

Particle Selection

Analytical procedures generally were the same at the field laboratory and at NRDL, with minor differences as noted.

Some of the sampling trays exposed during the heavier fallout were examined with a low-power binocular stereomicroscope to determine the size and shape of the particles. Each particle was typed according to shape and sized in situ. Only Shot B particle collections were studied for size distribution. Circular areas were randomly marked on each tray and in these areas, particles larger than 10 μ in diameter were studied. On the YAG-40 trays, a circle 1.2 cm in diameter was used, while a circle 0.6 cm in diameter was used on all other Shot B trays (analyzed at NRDL). No attempt was made to obtain size distribution information from the YAG-40-Shot A particles; these were selected to obtain a sufficient number of particles from all size groups present to provide reliable data.

Immediately after being sized, each particle was carefully scooped up with a hypodermic needle and suspended in a small glass vial for subsequent gamma counting.

Particle Shape and Size Determination

Particles were classified in three general categories on the basis of physical appearance:* spheroidal if spherical in character, irregular if irregular or angular, and dendrite-like when distinguished by an interlacing branching network structure of extreme delicacy (Fig. 1).

---

* The color of YAG-40 particles (both shots) was also determined; however, this parameter was not utilized in the present study.

Particle size was described by either of two size parameters, equivalent projected area diameter (D_a) or maximum diameter (D_m). The projected area method is conventional, and the area can be related to particle falling velocity - an important quantity in any fallout model. No significant physical relation can be attached to maximum diameter; however, it does offer ease of measurement and reproducibility. Diameters were measured with ocular micrometers having either a linear scale or a Fairs graticule (sizing circles). The linear scale was employed exclusively to size YAG-40-Shot B particles in terms of D_m. All other Shot B particles and the YAG-40-Shot A particles* were sized by the graticule system in terms of D_a, whereby particle area was compared with graticule area. Measurements were generally taken under a total magnification of 45X, although 19.5X and 9.9X were used occasionally by changing microscope objectives. In general, interpolation between scale units for either micrometer was not attempted, except in the case of YAG-40-Shot A particles.

Particle Activity Measurements

Particles were individually counted for relative gamma activity in a well scintillation counter** employing a 1-3/4-in. dia. x 2-in. thick Tl-activated NaI crystal detector. In the case of measurements made at the site (YAG-40 collections), three 1-min counts were taken and, for convenience, the median was selected as the representative value. Where gross counting rates were less than twice background, single 1-min counting was done. Particles analyzed at NRDL were all counted for single 1-min periods. Backgrounds were on the order of 300 c/m. Experimentally determined coincidence loss corrections were applied when activities exceeded 10^6 c/m. Response characteristics of the several well counters employed were normalized, where necessary, through laboratory gamma standards.

Field measurements were taken from about H + 5 to 40 hr and NRDL measurements from about H + 300 to 650 hr. Activities were corrected to an appropriate reference time for analysis, and experimental decay curves were determined by following the decay characteristics of selected particles and aliquots of particle solutions.

---

* A small group of YAG-40-Shot A particles was sized in terms of circumscribed diameter (D_c) by utilizing graticule circumference. Because of its small number, this group was not included in this study but is listed in Appendix A.

** An end-on 1-1/2-in. dia. x 1/2-in. thick NaI scintillator was occasionally used to count exceptionally active particles. A conversion factor of 10 from shelf 1 to well was obtained from lower-activity particles counted in both counters, and has been applied to all results.

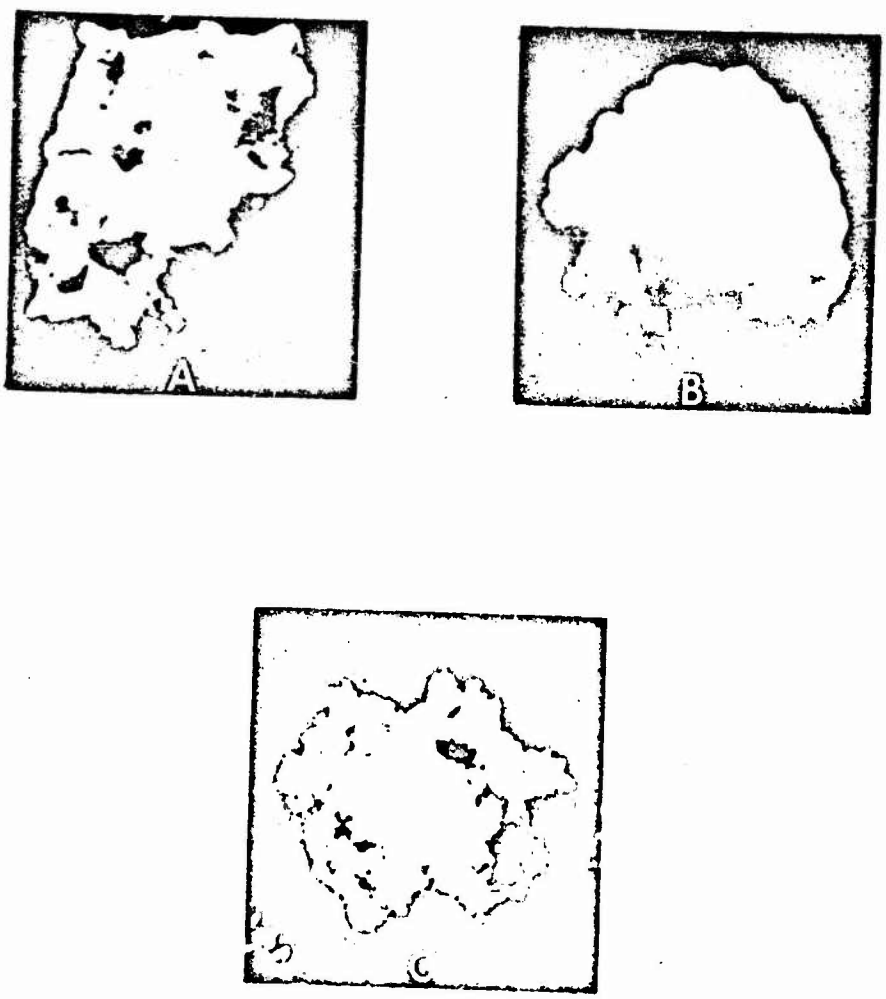

Fig. 1 Examples of Types of Particles Studied.
A. Irregular. B. Spheroidal. C. Dendrite-like.

RESULTS AND DISCUSSION

Individual particle data are listed in Appendix A. The results of particle measurements are summarized in Table 1, where the distribution and activity characteristics of the size and size-type group of each sample collection are listed. The small number in some of the groups emphasizes the difficulties in obtaining sufficient single particle data and indicates that the reliability of such data is low. Particles smaller than 31 μ were not studied in the YAG-40-Shot A group - probably because of investigator bias toward larger sizes and the difficulties of sizing small particles imbedded in grease.

Particle Size Distribution

For the size distribution studies, it was not possible to mark a tray area completely at random because of practical considerations. Areas selected were limited to those having 10 to 20 particles sufficiently well spaced to permit pick-up. A study[10] has shown that the quantities of fallout deposited at the different collector positions in the standard platform were affected by varying degrees of wind bias; for this reason the particle size distribution data as given may not be representative of the geographical location. Since the effects of wind bias were lower in the case of the YAG-40-Shot B sample, this collection is considered to be reasonably representative of location.

Activity Characteristics

The most notable aspect of the activity data is the wide range of activities associated with each size group and size-type subgroup. Though activity ranges were extensive, variation through each range was nearly continuous; however, in a number of cases, extreme low or high values occurred. The activity characteristics of each size group of each collection are given in Table 1 in terms of minimum activity, maximum activity, median activity, and group activity (except YAG-40-Shot A) - which is obtained by summing individual particle activities. Due to the lower frequencies of the size-type subgroups, only their median activities and subgroup activities are listed.

As discussed in the following section, there are indications that the activities of a size-type subgroup may follow a normal distribution, in

TABLE 1

Distribution and Activity Characteristics of Particle Size and Type
(YAG-40-Shot A (non-random sample); Activities at H + 12)

Size Group (μ)	Composite				Irregular		Spheroi	
	Number of Particles	Activity (well c/m)			Frequency	Median Activity (well c/m)	Frequency	(
		Minimum	Maximum	Median				
31-42	8	78	11,354	835	6	1,255	2	
43-60	20	33	833,600	6,985	13	6,797	5	
61-84	37	58	459,321	12,213	27	11,871	10	
85-102	6	4,460	50,608	32,434	6	32,434	0	
103-120	42	69	525,449	41,412	24	25,083	12	
121-145	13	19,063	683,362	77,622	4	24,771	8	
146-170	34	3,686	771,326	113,209	12	65,067	15	
171-200	24	3,816	1,675,122	166,982	13	92,070	11	
201-240	27	25,565	1,310,318	168,795	22	152,710	2	
241-260	25	32,178	726,969	145,494	22	131,935	0	
261-315	9	53,105	493,500	223,424	6	181,658	0	
316-382	1	---	---	1,774,146	1	1,774,146	0	

Continued

1

TABLE 1

istribution and Activity Characteristics of Particle Size and Type Groups
(YAG-40-Shot A (non-random sample); Activities at H + 12)

posite		Irregular		Spheroidal		Dendrite-like	
tivity (well c/m)			Median Activity		Median Activity		Median Activity
Maximum	Median	Frequency	(well c/m)	Frequency	(well c/m)	Frequency	(well c/m)
11,354	835	6	1,255	2	387	0	---
833,600	6,985	13	6,797	5	6,631	2	423,448
459,321	12,213	27	11,871	10	17,450	0	---
50,608	32,434	6	32,434	0	---	0	---
525,449	41,412	24	25,083	12	87,795	6	56,728
683,362	77,622	4	24,771	8	304,282	1	58,585
771,326	113,209	12	65,067	15	259,931	7	114,803
1,675,122	166,982	13	92,070	11	457,315	0	---
1,310,318	168,795	22	152,710	2	420,669	3	221,828
726,969	145,494	22	131,935	0	---	3	217,674
493,500	223,424	6	181,658	0	---	3	365,685
---	1,774,146	1	1,774,146	0	---	0	---

2

TABLE 1 (Contd)

Distribution and Activity Characteristics of Particle Size a
(YAG-40-Shot B, Activities at H + 300)

Size Group (μ)	Number of Particles	Composite Activity (well c/m) Minimum	Maximum	Median	Group	Irregular Frequency	Activity (well c/m) Median	Group	Sph Ac Frequency
11-33	5	0	3,222	372	4,209	4	218	987	1
34-66	28	0	80,483	1,596	191,972	17	1,860	169,221	3
67-99	49	0	47,181	7,103	519,360	24	8,293	241,291	11
100-132	61	0	48,757	15,129	998,547	38	16,889	685,795	8
133-165	78	4	53,806	17,243	1,564,034	40	15,247	678,500	8
166-198	46	0	387,697	25,877	1,628,637	30	24,503	803,776	4
199-231	19	19	99,094	34,435	693,709	12	34,078	402,758	0
232-264	16	94	136,203	49,444	849,701	4	34,571	125,221	0
265-297	10	8	122,553	55,708	599,034	2	43,855	87,709	1
298-330	14	19	155,625	55,282	926,556	2	63,499	126,985	0
331-363	1	---	---	64,086	64,086	0	---	---	0
364-396	2	3,176	138,856	71,016	142,032	0	---	---	1
397-429	0	---	---	---	---	-	---	---	-
430-462	3	1,267	39,308	10,997	51,572	2	6,132	12,264	1
463-495	0	---	---	---	---	-	---	---	-
496-528	2	92,688	197,740	145,214	290,428	0	---	---	0
Total	334				8,523,877	175		3,334,507	38
Contribution (%)						52.4		39.1	11.4

Continued

TABLE 1 (Contd)

istribution and Activity Characteristics of Particle Size and Type Groups
(YAG-40-Shot B, Activities at H + 300)

well c/m)		Irregular			Spheroidal			Dendrite-like		
			Activity (well c/m)			Activity (well c/m)			Activity (well c/m)	
Median	Group	Frequency	Median	Group	Frequency	Median	Group	Frequency	Median	Group
372	4,209	4	218	987	1	3,222	3,222	0	---	---
1,596	191,972	17	1,860	169,221	3	3,424	9,532	8	1,125	13,219
7,103	519,360	24	8,293	241,291	11	14,776	194,762	14	4,111	83,307
15,129	998,547	38	16,889	685,795	8	8,932	66,648	15	13,504	246,104
17,243	1,564,034	40	15,247	678,500	8	10,827	88,475	30	26,224	797,059
25,877	1,628,637	30	24,503	803,776	4	3,757	[illegible],261	12	37,363	794,600
34,435	693,709	12	34,078	402,758	0	---	---	7	34,591	290,951
49,444	849,701	4	34,571	125,221	0	---	---	12	53,599	724,480
55,708	599,034	2	43,855	87,709	1	8	8	7	72,695	511,317
55,282	926,556	2	63,499	126,985	0	---	---	12	55,282	799,571
64,086	64,086	0	---	---	0	---	---	1	64,086	64,086
71,016	142,032	0	---	---	1	3,176	3,176	1	138,856	138,856
---	---	-	---	---	-	---	---	-	---	---
10,997	51,572	2	6,132	12,264	1	39,308	39,308	0	---	---
---	---	-	---	---	-	---	---	-	---	---
145,214	290,428	0	---	---	0	---	---	2	145,214	290,428
	8,523,877	175		3,334,507	38		435,392	121		4,753,978
		52.4		39.1	11.4		5.1	36.2		55.8

TABLE 1 (contd)

Distribution and Activity Characteristics of Particle Size and T
(YAG-39-Shot B, Activities in Well c/m at H + 300)

Size Group (μ)	Number of Particles	Frequency With Zero Activity	Composite Activity (well c/m) Minimum	Maximum	Median	Group	Irregular Frequency	Activity (well c/m) Median	Group	Frequency
10-21	20	7	0	232	18	1,161	5	0	57	15
22-30	51	19	0	477	14	3,115	34	11	1,532	16
31-42	59	27	0	872	16	5,263	45	9	3,554	3
43-60	63	17	0	5,451	54	12,481	31	64	1,335	3
61-84	49	8	0	2,180	64	11,992	29	61	5,666	0
85-120	41	4	0	8,994	317	80,647	25	543	48,395	1
121-170	9	1	0	15,755	494	32,430	6	676	16,170	1
171-240	5	0	1,958	27,120	16,402	80,525	2	10,757	21,514	1
241-340	3	0	5,658	76,906	34,344	166,908	3	34,344	116,908	0
341-480	0	-	---	---	---	---	-	---	---	-
481-680	0	-	---	---	---	---	-	---	---	-
Total	300					344,522	180		215,131	40
Contribution (%)							60.0		62.4	13.4

Continued

TABLE 1 (contd)

ibution and Activity Characteristics of Particle Size and Type Group
(YAG-39-Shot B, Activities in Well c/m at H + 300)

			Irregular			Spheroidal			Dendrite-like		
ity (well c/m)				Activity (well c/m)			Activity (well c/m)			Activity (well c/m)	
mum	Median	Group	Frequency	Median	Group	Frequency	Median	Group	Frequency	Median	Group
32	18	1,161	5	0	57	15	61	1,104	0	---	---
77	14	3,115	34	11	1,532	16	68	1,583	1	0	0
72	16	5,263	45	9	3,554	3	0	307	11	22	1,402
51	54	12,481	31	64	1,335	3	469	9,913	29	27	1,233
80	64	11,992	29	61	5,666	0	---	---	20	64	6,326
94	317	80,647	25	543	48,395	1	739	739	15	98	31,513
55	494	32,430	6	676	16,170	1	494	494	2	7,883	15,766
20	16,402	80,525	2	10,757	21,514	1	27,120	27.120	2	15,946	31,891
06	34,344	166,908	3	34,344	116,908	0	---	---	0	---	---
---	---	---	-	---	---	-	---	---	-	---	---
---	---	---	-	---	---	-	---	---	-	---	---
		344,522	180		215,131	40		41,260	80		88,131
			60.0		62.4	13.4		12.0	26.7		25.6

2

TABLE 1 (contd)

Distribution and Activity Characteristics of Particle Size and Ty
(LST-611-Shot B, Activities at H + 300)

Size Group (μ)	Number of Particles	Frequency With Zero Activity	Composite Activity (well c/m) Minimum	Maximum	Median	Group	Irregular Frequency	Activity (well c/m) Median	Group	S Frequency
10-21	39	18	0	161	19	1,897	22	13	1,017	17
22-30	23	10	0	212	11	939	22	24	929	1
31-42	32	12	0	343	41	2,269	27	44	1,820	3
43-60	26	13	0	1,112	10	2,436	20	19	2,261	4
61-84	12	2	0	7,909	108	14,161	7	198	9,598	1
85-120	14	3	0	11,941	1,994	47,417	8	4,201	35,755	1
121-170	20	3	0	17,640	8,699	176,014	14	11,323	150,672	0
171-240	6	1	0	39,681	11,438	82,752	5	8,798	68,472	0
241-340	0	-	-	---	---	---	-	---	---	-
341-480	0	-	-	---	---	---	-	---	---	-
481-680	0	-	-	---	---	---	-	---	---	-
Total	172					327,885	125		270,524	27
Contribution (%)							72.7		82.5	15.7

Continued

1

TABLE 1 (contd)

bution and Activity Characteristics of Particle Size and Type Groups
(LST-611-Shot B, Activities at H + 300)

			Irregular			Spheroidal			Dendrite-like		
ty (well c/m)				Activity (well c/m)			Activity (well c/m)			Activity (well c/m)	
mm	Median	Group	Frequency	Median	Group	Frequency	Median	Group	Frequency	Median	Group
51	19	1,897	22	13	1,017	17	19	880	0	---	---
12	11	939	22	24	929	1	10	10	0	---	---
43	41	2,269	27	44	1,820	3	29	106	2	172	343
12	10	2,436	20	19	2,261	4	0	118	2	29	57
09	108	14,161	7	198	9,598	1	128	128	4	53	4,435
41	1,994	47,417	8	4,201	35,755	1	3,282	3,282	5	0	8,380
40	8,699	176,014	14	11,323	150,672	0	---	---	6	883	25,342
31	11,438	82,752	5	8,798	68,472	0	---	---	1	14,280	14,280
--	---	---	-	---	---	-	---	---	-	---	---
--	---	---	-	---	---	-	---	---	-	---	---
--	---	---	-	---	---	-	---	---	-	---	---
		327,885	125		270,524	27		4,524	20		52,837
			72.7		82.5	15.7		1.4	11.6		16.1

2

TABLE 1 (contd)

Distribution and Activity Characteristics of Particle Size and Ty
(YFNB 29-Shot B, Activities at H + 300)

Size Group (μ)	Number of Particles	Frequency With Zero Activity	Composite Activity (well c/m) Minimum	Maximum	Median	Group	Irregular Frequency	Activity (well c/m) Median	Group	S Frequency
10-21	33	6	0	506	48	2,524	20	44	1,683	13
22-30	18	9	0	610	13	1,299	15	0	1,107	3
31-42	19	5	0	534	62	1,853	16	53	1,487	0
43-60	22	4	0	395,842	490	408,345	15	167	404,211	1
61-84	12	2	0	5,554	272	11,149	8	272	8,493	1
85-120	16	0	90	7,801	926	37,525	7	785	20,133	4
121-170	12	1	0	83,316	2,029	118,296	6	1,433	93,965	0
171-240	8	1	0	21,240	5,186	55,882	3	6,590	19,723	1
241-340	9	0	3,614	619,448	61,653	1,445,691	6	112,640	720,292	1
341-480	13	0	6,204	1,698,631	71,445	3,265,945	9	142,176	2,918,445	3
481-680	7	0	50,641	489,310	184,800	1,610,536	5	184,800	1,086,799	0
Total	169					6,959,045	110		5,276,338	27
Contribution (%)							65.1		75.8	16.0

Continued

TABLE 1 (contd)

istribution and Activity Characteristics of Particle Size and Type Groups
(YFNB 29-Shot B, Activities at H + 300)

ite			Irregular			Spheroidal			Dendrite-like		
ctivity (well c/m)			Activity (well c/m)			Activity (well c/m)			Activity(well c/m)		
Maximum	Median	Group	Frequency	Median	Group	Frequency	Median	Group	Frequency	Median	Group
506	48	2,524	20	44	1,683	13	70	841	0	---	---
610	13	1,299	15	0	1,107	3	60	192	0	---	---
534	62	1,853	16	53	1,487	0	---	---	3	84	366
395,842	490	408,345	15	167	404,211	1	9	9	6	848	4,125
5,554	272	11,149	8	272	8,493	1	927	927	3	88	1,729
7,801	926	37,525	7	785	20,133	4	554	4,472	5	1,625	12,920
83,316	2,029	118,296	6	1,433	93,965	0	---	---	6	2,421	24,331
21,240	6,186	55,882	3	6,590	19,723	1	21,240	21,240	4	2,728	14,919
719,448	61,653	1,445,691	6	112,640	720,292	1	61,653	61,653	2	331,873	663,746
398,631	71,445	3,265,945	9	142,176	2,918,445	3	71,446	341,296	1	6,204	6,204
389,310	184,800	1,610,536	5	184,800	1,086,799	0	---	---	2	261,869	523,737
		6,959,045	110		5,276,338	27		430,630	32		1,252,077
			65.1		75.8	16.0		6.0	18.9		18.0

2

TABLE 1 (contd)

Distribution and Activity Characteristics of Particle Size and Type Gr
(YFNB 13-Shot B, Activities at H + 300)

Size Group (μ)	Composite						Irregular			Spheroid	
	Number of Particles	Frequency With Zero Activity	Activity (well c/m) Minimum	Maximum	Median	Group	Frequency	Activity (well c/m) Median	Group	Frequency	Activity Median
10-21	27	8	0	250	33	1,488	19	35	868	8	29
22-30	54	22	0	399	25	3,014	38	24	1,933	16	38
31-42	28	7	0	356	87	2,820	25	91	2,775	2	23
43-60	19	3	0	1,225	74	2,707	15	74	2,345	0	---
61-84	8	2	0	1,166	83	1,612	6	83	446	0	---
85-120	11	4	0	2,424	125	5,618	6	135	963	1	0
121-170	2	0	78	7,126	3,602	7,204	1	78	78	0	---
171-240	1	1	---	---	0	0	0	---	---	0	---
241-340	0	-	---	---	---	---	-	---	---	-	---
341-480	2	0	792,378	984,805	888,592	1,777,183	2	888,592	1,777,183	0	---
481-680	1	1	---	---	0	0	0	---	---	1	0
Total	153					1,801,646	114		1,786,591	27	
Contribution (%)							74.5		99.2	17.6	

TABLE 1 (contd)

ution and Activity Characteristics of Particle Size and Type Groups
(YFNB 13-Shot B, Activities at H + 300)

		Irregular			Spheroidal			Dendrite-like		
(well c/m)			Activity (well c/m)			Activity (well c/m)			Activity (well c/m)	
Median	Group	Frequency	Median	Group	Frequency	Median	Group	Frequency	Median	Group
33	1,488	19	35	868	8	29	620	0	---	---
25	3,014	38	24	1,933	16	38	1,081	0	---	---
87	2,820	25	91	2,775	2	23	45	1	0	0
74	2,707	15	74	2,345	0	---	---	4	87	362
83	1,612	6	83	446	0	---	---	2	583	1,166
125	5,618	6	135	963	1	0	0	4	1,116	4,655
3,602	7,204	1	78	78	0	---	---	1	7,126	7,126
0	0	0	---	---	0	---	---	1	0	0
---	---	-	---	---	-	---	---	-	---	---
888,592	1,777,183	2	888,592	1,777,183	0	---	---	0	---	---
0	0	0	---	---	1	0	0	0	---	---
	1,801,646	114		1,786,591	27		1,746	12		13,309
		74.5		99.2	17.6		0.1	7.8		0.7

2

which case the mean and median are equal. The median therefore is used in this study as an estimate of the mean, since it depends (at least in the doubtful activity region) only on the number of particles. In addition the median value is less distorted by the extreme values that occur in some cases.

Only the field data (YAG-40-Shot A and YAG-40-Shot B) are considered reliable for activity-size and activity distribution information. This set of data shows that the activity range and median activity both increase with particle size. The measurements made at NRDL are less useful, showing a high percentage of particles with very low or zero activities. These particles were counted at late times, and their activities had decayed to or past the limits of detection. In the case of zero activities the question of which of these decayed past detection and which were originally inactive cannot be resolved. It is noteworthy that all the YAG-40-Shot A particles studied were active and 98% of the YAG-40-Shot B particles were active.

Activity Distribution Studies

A preliminary study of the activity distribution within a size group and a size-type subgroup was conducted with the field data. The study was limited to considering whether or not the distribution of activities followed normal or log-normal distribution functions. A normal distribution tendency was exhibited only by the size-type subgroups containing 30 or more particles, as is shown by their data plotted on normal-probability paper in Figs. 2 through 5. A distribution function could not be assigned to the other groups.

The YAG-40-Shot B particles provide information on the distribution of activity among size groups as well as the distribution of activity by particle type within a size group. The activities, listed in Table 1, are detailed in Table 2.

Activity and Size Relationship

With the field data, median activities of size and size-type groups were plotted against mean diameters to study the activity-size relationships and the influence of particle type in such relations. Figure 6 depicts the log-log plots of the YAG-40-Shot A particles and Fig. 7, the YAG-40-Shot B group. Shot A dendrite-like and Shot B spheroidal particles were not studied typewise because their data were too sparse; however they are included in the composite group studies. In each plot the locus of points suggested a linear relationship; consequently regression lines were fitted by means of a modified least squares method. In this method the median activity of the group was weighted by the number of particles in the group. For calculation, activities greater than 10^4 c/m were

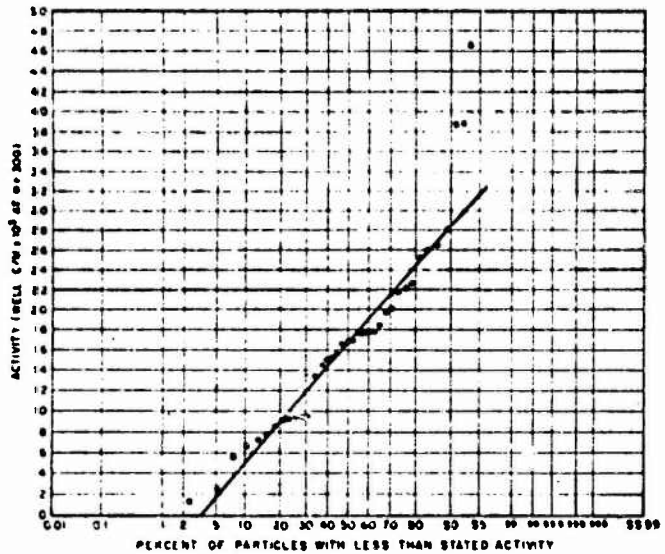

Fig. 2 Particle Activity Probability Plot. YAG-40-Shot B collection; 100-132 μ size range; irregular type; number of particles, 38.

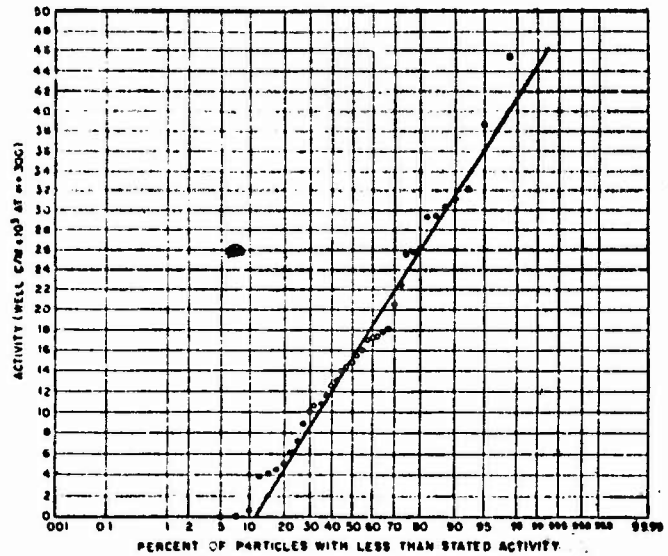

Fig. 3 Particle Activity Probability Plot. YAG-40-Shot B collection; 133-165 μ size range; irregular type; number of particles, 40.

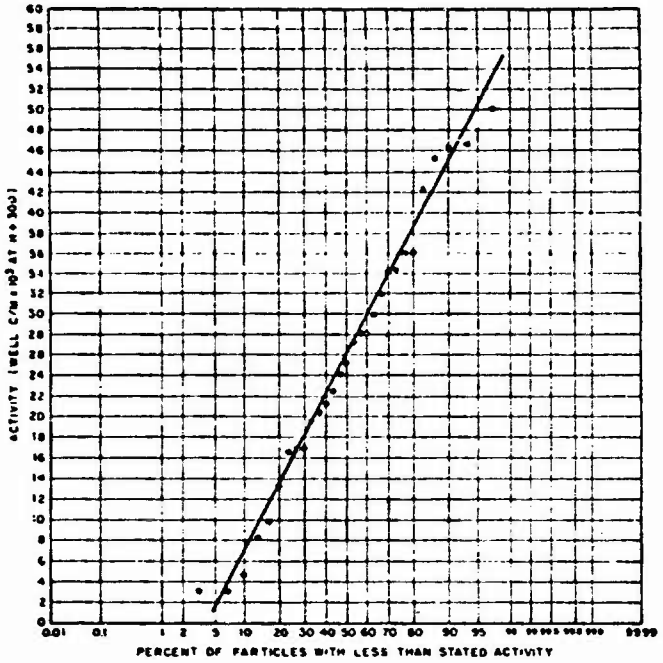

Fig. 4 Particle Activity Probability Plot. YAG-40-Shot B collection; 133-165 μ size range; dendrite-like type; number of particles, 30.

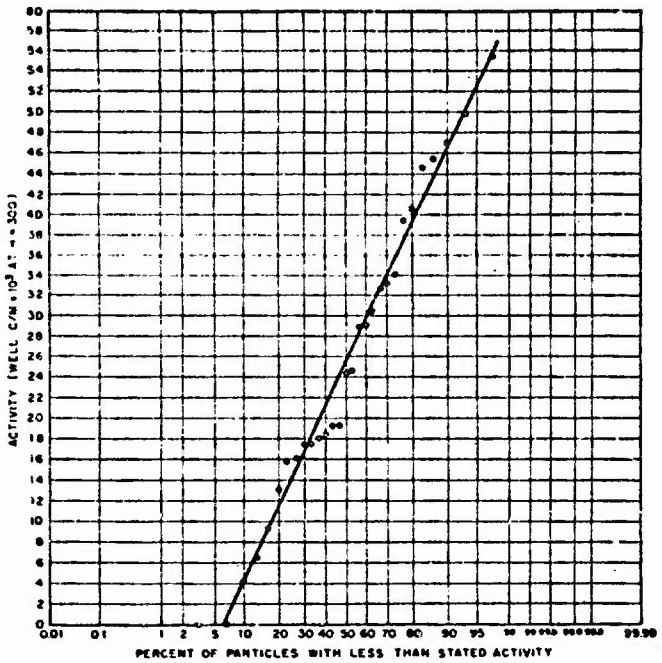

Fig. 5 Particle Activity Probability Plot. YAG-40-Shot B collection; 166-198 μ size range; irregular type; number of particles, 30.

TABLE 2

Distribution of Activity with Size Group and Type,
YAG-40-Shot B Particles

Size Group (μ)	Percent of Total Sample Activity			
	Composite	Irregular	Spheroidal	Dendrite-like
11-33	0.05	0.01	0.04	---
34-66	2.25	1.99	0.11	0.16
67-99	6.09	2.83	2.28	0.98
100-132	11.71	8.05	0.78	2.89
133-165	18.35	7.96	1.04	9.35
166-198	19.10	9.42	0.35	9.32
199-231	8.14	4.72	---	3.41
232-264	9.97	1.47	---	8.50
265-297	7.03	1.03	<0.01	6.00
298-330	10.87	1.49	---	9.38
331-363	0.75	---	---	0.75
364-396	1.67	---	0.04	1.63
397-429	---	---	---	---
430-462	0.61	0.14	0.46	---
463-495	---	---	---	---
496-528	3.41	---	---	3.41
Total	100.00	39.11	5.10	55.78

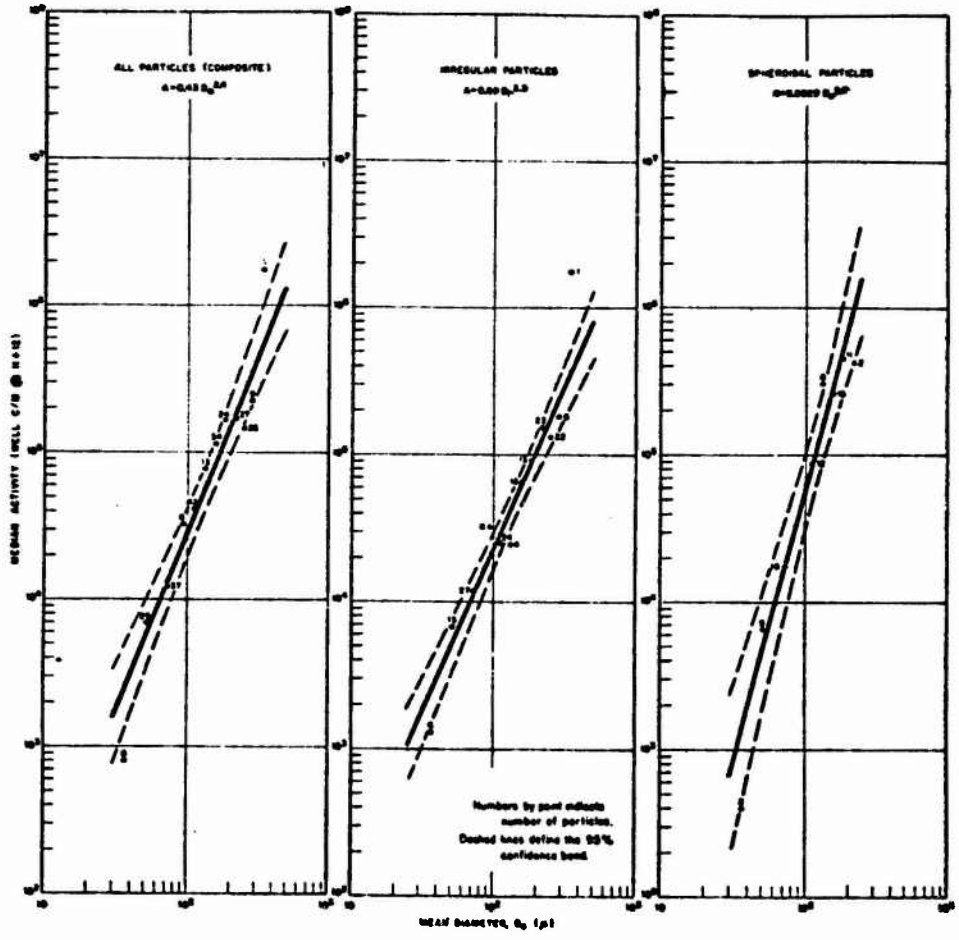

Fig. 6 Median Activity Versus Mean Size, YAG-40-Shot A Particles

rounded to three significant figures and lower activities to the nearest hundred c/m. Dashed lines representing the 95% confidence bands of the regression lines are also included. The equations of the regression lines are given in the figures, where:

A = median activity in well c/m at H + 300 (Shot B) or H + 12 (Shot A)

D_a = mean projected area diameter in microns

D_m = mean maximum diameter in microns

CONCLUSIONS

In view of the limited data no generalizations can be made; however, the results do warrant the following observations:

1. An extensive range of activities is associated with each size and size-type group. The field data indicate that the activities of a size-type group containing 30 or more particles follow a normal distribution.

2. The field data also show that the activity of irregular particles varies approximately as the square of the diameter, a surface area function. For spheroidal particles the activity varies with a function exponentially greater than a volume function. In the case of dendrite-like particles the activity varies with a function exponentially greater than the irregular particle function.

Approved by:

E. R. Tompkins

E. R. TOMPKINS
Head, Chemical Technology Division

For the Scientific Director

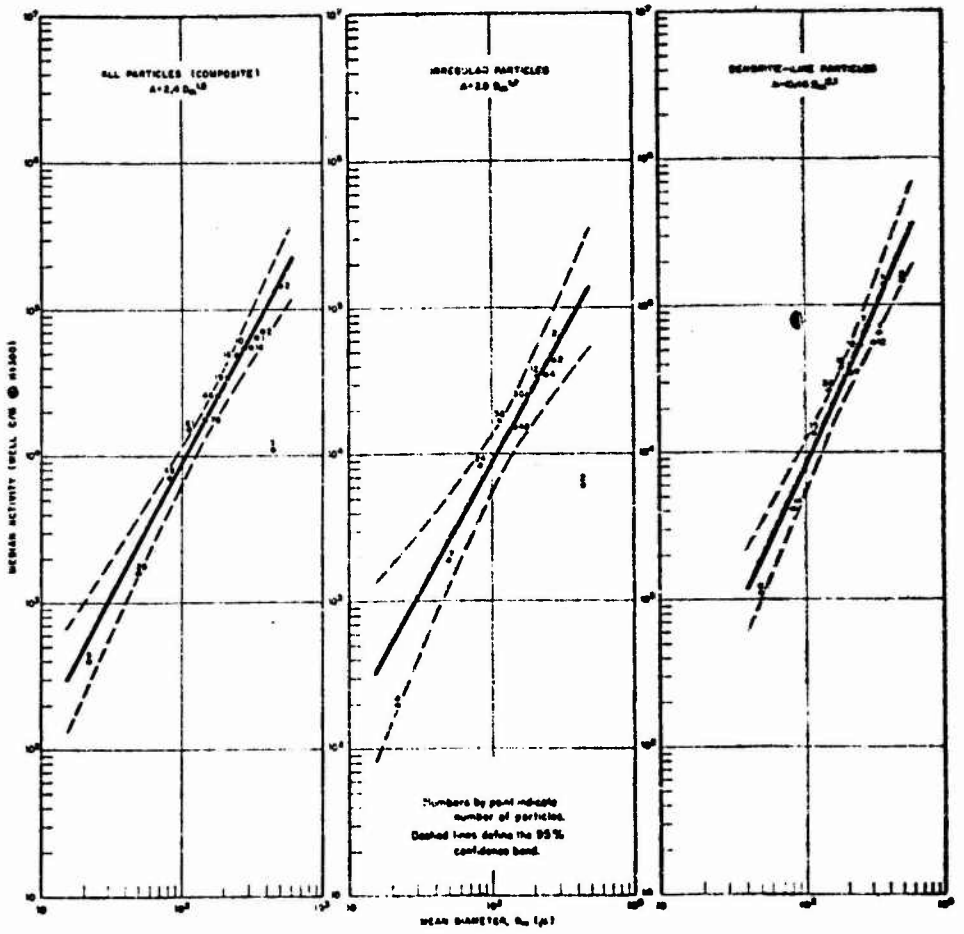

Fig. 7 Median Activity Versus Mean Size, YAG-40-Shot B Particles

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APPENDIX

MEASUREMENTS OF INDIVIDUAL PARTICLES

The size, shape, color (when determined) and corrected gamma activity of the particles investigated are listed in the following tables. In regard to particle shape, symbols S, I and D represent spheroidal, irregular, and dendrite-like respectively. Particle designation refers to the collecting tray and the sequential order in which the particle was studied. Discontinuities in sequential order indicate either labeling errors or analytical errors compelling the elimination of certain particles.

TABLE A.1

YAG-40-Shot A Particles

Particle Designation	Size (μ) D_a	Size (μ) D_c	Activity at H + 12 (net well c/m)	Shape	Color
311-1		380	649,329	D	white
2		250	97,790	D	white
3		380	349,670	D	white
4		360	756,096	D	white
5		360	276,729	D	white
6		180	123,092	I	white
7		360	323,721	D	white
8		260	125,882	S	white
9		260	261,715	D	yellow white
10		360	538,739	D	translucent white
11		180	124,580	I	yellow white
12		180	131,216	I	yellow white
13		260	120,333	I	white
322-1		360	542,297	D	white
2		360	199,538	S	white
3		315	177,259	D	white
4		315	452,764	I	white
5		285	67,343	I	white
6		310	57,076	I	white
7		285	18,485	I	white
8		260	251,425	I	white
9		260	144,225	I	white
10		260	59,662	I	yellow white
11		260	111,957	I	white
12		220	62,603	I	white
13		180	856,510	S	white
14		190	44,941	I	white
15		180	57,404	I	yellow white
16		130	34,862	I	white
17	240		603,872	S	white
18	240		378,999	I	white
19	78		1,295	I	white
20	145		26 094	I	white
21	120		834	I	white
22	110		69	I	bright yellow
23	170		20,637	I	white
24	120		89,922	S	white
25	240		168,795	I	white

Continued

TABLE A.1 (Contd)

YAG-40-Shot A Particles

Particle Designation	Size (μ) D_a	Size (μ) D_c	Activity at H + 12 (net well c/m)	Shape	Color
322-26	170		3,686	I	white
27	105		9,555	I	white
28	155		21,000	I	white
29	120		318,325	S	yellow
30	120		23,413	I	white
324- 1	260		373,126	I	
2	170		56,895	D	translucent white
3	84		3,842	I	translucent white
4	120		30,894	D	translucent white
5	105		34,872	I	translucent white
6	220		114,401	I	white
7	70		29,331	I	translucent white
8	60		13,295	D	translucent white
9	60		8,376	I	translucent white
10	290		53,105	I	white
11	220		132,656	I	white
12	220		236,946	I	white
13	260		112,922	I	white
14	60		833,600	D	translucent white
15	42		974	I	translucent white
16	220		724,800	I	yellow
17	260		340,488	I	white
18	42		1,535	I	translucent white
19	42		8,853	I	translucent white
20	35		233	I	translucent white
21	60		1,228	I	translucent white
22	180		457,315	S	translucent white
23	180		359,105	S	white
24	180		101,772	I	white
25	105		209,971	S	translucent yellow
26	50		12,303	I	white
27	84		85,446	S	white
28	155		259,931	S	white
29	84		16,928	I	white
30	170		60,499	D	white
31	180		120,470	I	white
32	65		12,213	S	translucent white
33.1	50		6,797	I	translucent white

Continued

TABLE A.1 (Contd)

YAG-40-Shot A Particles

Particle Designation	Size (μ) D_a	Size (μ) D_c	Activity at H + 12 (net well c/m)	Shape	Color
324-33.2	60		9,835	I	translucent white
34	120		31,464	D	translucent white
35	170		736,560	S	translucent white
36	110		498,102	D	translucent white
37	60		9,065	S	translucent white
38	120		19,958	I	white
39	60		6,631	S	translucent white
40	50		7,212	I	translucent white
41	120		68,758	S	translucent white
42	130		686,362	S	translucent yellow
43	120		85,669	S	translucent white
44	78		16,375	I	translucent white
45	60		4,319	I	translucent white
46	150		87,228	I	white
47	70		35,446	I	translucent white
48	240		28,292	I	white
49	240		479,678	I	white
50	260		726,969	I	white
51	170		247,700	S	translucent white
52	120		55,851	S	translucent white
53	150		424,430	S	translucent white
54	175		559,917	S	translucent white
55	42		78	S	black
56	130		535,070	S	translucent yellow
57	260		68,611	I	white
58	260		101,647	I	white
59	35		186	I	translucent white
325- 1	42		696	S	black
2	35		11,354	I	translucent white
3	200		26,932	I	white
4	50		1,029	I	translucent white
5	65		1,681	I	translucent white
6	78		58,528	S	translucent white
7	170		106,450	S	translucent white
8	170		89,071	I	translucent white
9	170		114,803	D	translucent white
10	285		224,952	I	white
11	105		38,135	I	white
12	70		10,783	I	translucent white

Continued

TABLE A.1 (Contd)

YAG-40-Shot A Particles

Particle Designation	Size (μ) D_a	Size (μ) D_c	Activity at H + 12 (net well c/m)	Shape	Color
325-13	70		16,623	*	translucent white
14	170		42,814	S	white
15.1	60		7,172	S	white
15.2	155		72,400	I	translucent white
16	120		73,073	I	white
17	70		11,871	I	translucent white
18	120		44,689	I	translucent white
19	260		223,669	I	white
20	120		51,691	D	translucent white
21	70		18,696	I	translucent white
22	90		50,608	I	translucent white
23	105		21,985	I	translucent white
24	84		13,973	I	translucent white
25	145		69,450	I	translucent white
26	65		322	S	black
27	120		23,300	I	translucent white
28	120		525,449	S	yellow
29	145		149,175	S	translucent white
30	155		540,656	S	translucent white
31	285		216,400	I	white
32	240		89,680	I	white
33	240		281,971	I	white
34	285		94,314	I	white
35	240		383,041	I	white
36	55		1,238	S	translucent white
37	78		8,008	I	translucent white
38	65		4,939	I	translucent white
39	84		17,971	I	translucent white
40	155		229,152	S	yellow
41	120		114,370	S	white
42	145		23,448	I	translucent white
43	220		221,828	D	white
44	180		124,527	S	translucent white
45	175		322,527	S	white
46	120		22,606	I	white
47	90		4,460	I	translucent white
48	90		26,369	I	translucent white
49	260		80,829	I	white
50	70		459,321	I	translucent white
51	105		19,900	S	translucent white

Continued

TABLE A.1 (Contd)

YAG-40-Shot A Particles

Particle Designation	Size (μ) D_a	Size (μ) D_c	Activity at H + 12 (net well c/m)	Shape	Color
325-52	155		194,019	S	translucent white
53	180		231,914	S	translucent white
54	110		66,106	I	white
55	105		26,752	I	translucent white
56	84		112,286	S	white
57	50		724	I	translucent yellow
58	78		5,027	I	translucent white
59	155		57,733	I	translucent white
60	130		459,389	S	white
61	60		3,406	I	translucent white
62	315		223,424	D	white
63	220		168,115	D	white
64	240		321,725	I	white
65	260		217,674	D	white
66	180		43,933	I	white
67	175		160,173	I	white
68	240		234,446	D	translucent white
69	240		156,190	I	translucent white
70	260		74,405	I	white
71	170		124,458	D	white
72	90		38,498	I	translucent white
73	70		58	S	black
74	155		37,950	I	translucent white
75	65		9,253	S	translucent white
76		130	17,417	D	white
77		260	473,000	S	white
78		320	499,326	I	white
79		84	17,506	I	white
80		60	2,717	S	white
81		200	134,781	I	translucent white
82		360	475,374	D	white
83		320	169,894	I	white
84		380	321,774	I	white
85		380	257,242	I	white
86		420	135,916	I	white
87		10	2,682	I	white
88		170	5,097	I	black
89		42	3,994	S	white
90		70	8,875	D	white
91		145	21,746	I	white
92		32	11,847	I	black

Continued

TABLE A.1 (Contd)

YAG-40-Shot A Particles

Particle Designation	Size (μ) D_a	Size (μ) D_c	Activity at H + 12 (net well c/m)	Shape	Color
325-93		102	1,885	I	black
94		200	3,100	S	black
95		15	3,580	I	white
96		70	2,093	I	yellow white
97		84	9,013	S	white
98		60	4,185	I	black
99		170	27,494	I	white
100		260	72,958	I	white
327- 1	170		53,964	I	white
2	90		38,919	I	white
3	180		6,515	I	white
4	260		110,612	I	white
5	180		173,790	I	white
6	260		130,925	I	white
7	150		246,763	S	white
8	120		129,485	S	white
9	84		22,028	I	white
10	170		80,174	S	white
11	120		60,113	I	white
12	155		88,631	I	white
13	245		280,597	I	white
14	180		92,070	I	white
15	200		421,090	I	white
16	145		104,847	S	white
17	130		49,757	S	white
18	65		5,705	I	white
19	110		48,954	I	white
20	240		62,294	I	white
21	315		493,500	D	white
22	220		34,665	I	white
23	260		150,600	I	white
25		380	76,138	I	white
26		380	137,075	I	white
27		380	387,759	I	white
28		380	132,317	D	white
29		170	11,480	D	white
30		145	10,068	I	white
31		170	123,165	D	white
32		102	26,191	I	white
33		60	22,016	D	white

Continued

TABLE A.1 (Contd)

YAG-40-Shot A Particles

Particle Designation	Size (μ) D_B	Size (μ) D_C	Activity at H + 12 (net well c/m)	Shape	Color
327-34		84	20	I	black
35		60	726	I	translucent grey
36		84	48	I	black
37	200		3,816	I	white
38	260		145,494	I	white
39	260		132,944	I	white
40	260		226,986	D	white
41	170		298,676	D	white
42	170		137,470	D	white
43	170		111,614	D	white
44	150		263,419	S	white
45	90		12,730	I	white
46	120		92,353	I	yellow white
47	220		77,991	I	white
48	180		20,265	I	white
49	260		93,124	I	white
50	180		54,217	I	white
51	120		20,533	S	white
52	120		12,480	I	white
53	120		71,571	I	white
54	170		535,943	S	white
55	84		49,695	S	white
56	220		25,565	I	white
57	84		6,071	I	white
58	84		7,975	I	white
59	145		489,692	S	yellow
60	260		162,461	D	white
61	130		58,585	D	white
62	315		259,521	I	white
63	200		121,838	S	white
64	260		333,518	I	white
65	180		258,810	I	white
66	315		365,685	D	white
67	120		15,629	I	white
68	84		25,125	I	white
69	170		79,119	I	white
70	145		77,622	S	white

Continued

TABLE A.1 (Contd)

YAG-40-Shot A Particles

Particle Designation	Size (μ) D_a	Size (μ) D_c	Activity at H + 12 (net well c/m)	Shape	Color
331- 1	380		1,774,146	I	white
2	220		237,465	S	white
3	220		50,440	I	translucent white
4	180		481,206	S	translucent white
5	180		874,396	S	yellow
6	200		1,675,122	S	yellow
7	200		1,228,093	S	yellow
8	240		1,007,132	I	yellow white
9	50		22,797	I	translucent white
335- 1	260		477,066	I	white
2	260		71,768	I	white
3	150		425,517	S	translucent yellow
4	220		1,310,318	I	white
5	65		28,116	I	translucent white
6	70		135	S	translucent white
7	55		33	S	yellow
8	260		357,380	I	white
9	120		32,672	I	white
10	120		77,306	D	yellow
11	260		32,178	I	white
12	84		9,765	I	translucent white
13	315		146,916	I	white
14	110		11,543	S	white
15	105		21,640	I	translucent white
16	60		1,838	I	translucent white
17	70		244	I	translucent white
18	170		771,326	I	translucent white
19	65		4,932	I	translucent white
20	60		20,147	I	translucent white
21	260		121,046	I	white
22	220		149,231	I	translucent white
23	105		46,522	I	translucent white
24	120		10,634	I	translucent white
25	220		132,781	I	translucent white
26	84		22,686	S	translucent white
27	170		438,630	S	yellow
28	63		13,232	I	translucent white
29	145		19,063	I	translucent white
30	120		61,764	D	translucent white

TABLE A.2

YAG-40-Shot B Particles

Particle Designation	Size, D_m (μ)	Activity at H + 300 (net well c/m)	Shape	Color
1832- 1	99	5,004	I	white
2	99	4,811	I	white
3	132	38,774	I	translucent white
4	165	6,259	I	white
5	198	24,635	I	white
6	115	21,834	I	white
8	132	19,887	I	grey
9.1	165	16,912	D	translucent white
9.2	330	52,625	D	translucent white
10	132	17,633	I	translucent white
11	115	41,668	D	white
12	297	34,065	D	white
13.1	198	72,028	D	translucent white
13.2	132	48,757	I	white
14	198	17,450	I	white
15	165	34,231	D	white
17	165	8,297	D	translucent white
18	297	54,011	I	translucent white
20	99	10,207	I	white
21	330	33,667	D	white
22	231	35,442	I	white
1834- 1	198	13,081	I	white
2	231	89,500	D	white
3	165	29,930	D	white
4	198	18,137	I	white
5	165	21,254	D	white
6	132	1,352	I	white
7	264	100,540	D	white
8	66	1,910	I	white
9	198	17,505	I	white
10	99	4,310	I	white
11	231	14,761	I	white
1836- 1	165	31,928	D	white
2	132	16,814	I	white
3	165	16,673	D	white
4	198	15,803	I	white
5	165	3,914	I	white
6	198	19,241	I	white

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

Particle Designation	Size, D_m (μ)	Activity at H + 300 (net well c/m)	Shape	Color
1836- 7	165	42,303	D	white
8	165	25,200	D	white
9	165	46,350	D	white
10	99	11,838	D	white
1837- 1	198	45,351	I	translucent grey
2	66	45,657	I	white
3	66	4,024	I	white
4	132	7,743	I	white
5	132	12,562	D	white
6	66	5,254	S	white
7	132	16,964	I	white
8	132	5,634	I	white
9	132	12,833	S	white
10	198	22,748	S	white
11	330	61,357	D	translucent white
12	132	25,277	I	grey
1838- 1	396	138,856	D	white
2	165	26,257	I	white
3	165	8,928	I	white
4	165	32,104	I	white
5	264	50,273	D	white
6	165	9,886	D	white
7	198	18,441	I	white
8	181	19,505	I	white
9	330	91,362	D	white
10	165	17,516	I	white
11	33	3,222	S	translucent grey
12	33	372	I	white
1839- 1	198	8	I	translucent yellow
2	165	12,688	I	white
3	165	5,148	I	white
4	198	7,501	S	white
5	297	33,698	I	white
6	132	10,679	S	white
7	231	19	I	grey
8	264	94	I	white

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

Particle Designation	Size, D_m (μ)	Activity at H + 300 (net well c/m)	Shape	Color
1840- 1	165	53,806	D	translucent white
2	462	39,308	S	translucent white
3	132	333	S	translucent white
4	396	3,176	S	translucent white
5	165	716	I	grey
6	99	11,444	I	white
1841- 1	165	27,248	D	white
2	132	4,566	S	white
3	165	17,109	I	white
1842- 1	198	29,118	I	white
2	297	122,553	D	white
3	231	39,353	I	white
4	264	136,203	D	white
5	231	18,081	I	white
6	231	33,721	I	white
7	115	7,184	S	white
8	99	42,043	S	translucent white
9	132	9,534	I	white
10	66	3,424	S	white
11	165	10,762	I	white
12	33	64	I	grey
1843- 1	242	48,615	D	white
2	66	5,805	D	white
3	66	2,420	D	white
4	132	13,327	S	white
5	132	22,787	D	white
6	132	14,729	D	white
7	132	17,694	S	white
8	99	9,051	S	white
9	99	2,294	D	white
10	99	2,035	D	white
11	165	50,055	D	white
12	99	7,354	I	white
13	132	7,220	I	white
14	297	57,404	D	white
15	49	642	I	white
16	165	16,953	D	white

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

Particle Designation	Size, D_m (μ)	Activity at H + 300 (net well c/m)	Shape	Color
1843-17	99	1,444	I	white
18	99	1,816	I	white
19	66	1,589	I	white
20	99	3,564	D	white
21	132	6,696	I	white
22	132	7,390	D	white
1844- 1	456	1,267	I	grey
2	456	10,997	I	white
3	99	14,776	S	white
4	264	59,341	D	white
5	99	6,848	I	white
6	198	32,713	I	white
7	231	34,435	I	white
8	330	52,152	D	translucent white
9	198	34,091	I	white
10	165	4,262	S	white
11	198	68,470	I	translucent grey
12	165	17,377	I	white
13	165	28,168	D	translucent grey
14	264	27,835	I	white
15	99	21,574	S	translucent grey
1848- 1	49	22	I	white
1849- 1	165	10,023	I	white
2	66	0	I	white
3	165	63	I	grey
1852- 1	82	0	I	grey
2	198	4,341	I	white
4	99	9,840	I	white
5	132	6,021	D	white
6	264	35,049	D	white
7.1	264	37,706	D	white
7.2	66	1,126	D	white
8	231	37,324	D	white
9	132	8,691	I	white
10	231	37,727	I	white
11	132	15,129	I	white
12	66	49	F	white
13	132	28,060	I	white
14	33	551	I	white

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

Particle Designation	Size, D_m (μ)	Activity at H + 300 (net well c/m)	Shape	Color
1855- 2	99	6,819	D	white
4	132	18,490	I	white
5	66	1,476	I	white
6	132	2,578	I	white
7	264	62,776	D	white
8	198	28,934	I	white
9	82	968	I	white
10	297	72,695	D	white
11	99	7,089	D	white
12	132	15,694	D	white
13	99	4,465	S	white
16	99	3,908	D	white
17	132	3,355	D	white
18	198	12	S	translucent grey
19	165	4,779	D	white
20	66	1,123	D	white
21	49	0	I	yellow
24	33	0	I	yellow
27	66	0	I	yellow white
29	297	8	S	translucent white
1856- 1	144	14,290	S	white
2	144	11,005	S	white
3	144	8,519	S	white
4	216	52,934	D	white
5	72	6,204	S	white
6	72	27,478	S	white
7	144	4	I	translucent white
8	66	2,733	I	grey
9	99	18,484	I	white
2125- 1	99	29,328	S	white
2	66	80,483	I	white
3	132	16,619	I	white
4	198	16,120	I	white
5	198	49,732	I	white
6	165	14,531	I	white
7	231	29,285	D	white
8	330	155,625	D	white
9.1	165	15,532	I	white

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

Particle Designation	Size, D_m (μ)	Activity at H + 300 (net well c/m)	Shape	Color
2125- 9.2	330	34,430	D	white
10	99	4,276	I	white
11	99	2,774	I	white
12	82	7,103	S	white
13	99	3,373	I	white
14	165	29,535	I	white
15	132	13,504	D	white
16	66	1,860	I	white
17	99	1,214	D	white
18	99	643	D	white
2129- 1	330	19	I	yellow
2	132	46,505	I	white
3	165	10,965	I	white
4	165	4,155	I	white
6	99	3,579	D	translucent white
7	165	3,107	D	translucent white
8	99	23,572	S	white
9	99	9,168	S	white
11	198	27,119	D	white
12	66	2,320	I	white
13	264	46,180	D	white
14	198	20,240	D	white
16	99	9,232	I	white
17	66	1,018	D	white
18	99	19,214	I	white
2131- 1	264	56,924	D	white
2	99	17,466	D	white
3	132	17,773	I	white
4	330	50,881	D	white
5	264	14,730	D	white
6	132	22,624	I	white
7	330	100,153	D	white
8	99	12,407	I	white
9	198	28,450	D	white
10	132	9,259	I	white
11	132	13,291	D	white
12	330	53,816	D	white
13	66	13	I	grey

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

Particle Designation	Size, D_m (μ)	Activity at H + 300 (net well c/m)	Shape	Color
2132- 1	198	171	I	white
2	132	32	S	grey
3	181	47,067	D	translucent white
4	49	854	S	grey
5	330	56,756	D	white
6	165	4	I	red
7.1	504	92,688	D	white
7.2	165	46,612	D	white
8	198	6,562	I	white
2133- 1	132	9,508	I	white
2	99	6,601	D	white
3	198	32,125	D	white
4	165	20,588	D	white
5	231	50,840	I	white
6	132	15,682	I	white
7	231	34,591	D	white
8	297	52,721	D	white
9	132	13,476	D	white
10	132	9,572	I	white
11	165	14,041	I	white
12	165	24,173	D	white
13	66	76	D	grey
2136- 1	165	29,452	I	white
2	165	36,061	D	white
3	99	4,313	D	white
4	66	1,602	D	white
5	132	31,996	D	white
6	165	45,461	I	white
7	165	30,386	I	white
8	132	26,080	I	white
9	165	34,484	D	white
10	132	20,142	I	white
11	66	4,117	I	grey
12.1	198	24,372	I	white
12.2	165	18,244	I	white
13	132	24,035	D	white
14	132	13,549	I	white
16	165	19,601	D	white
17	132	17,619	I	white
19	198	33,286	I	white

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

Particle Designation	Size, D_m (μ)	Activity at H + 300 (net well c/m)	Shape	Color
2137- 1	198	42,601	D	white
2	132	38,636	I	white
3	148	10,649	S	white
4	165	45,263	D	grey
5	231	25,589	D	white
6	363	64,086	D	white
8	132	26,442	I	white
10	198	44,571	I	white
2138- 1	165	13,173	I	white
2	198	0	S	grey
3	99	10,503	I	white
2139- 1	99	14,407	I	white
2	165	17,874	I	white
3	165	11,718	I	white
4	132	17,601	I	white
5	132	14,521	I	white
6	165	13,273	D	white
2142- 1	198	39,469	I	white
2	198	19,008	D	white
3	198	60,256	D	white
4	165	7,319	I	white
6	165	22,536	D	white
7	165	3,121	D	white
8	297	90,809	D	white
9	165	31,123	I	white
10	99	14,443	I	white
11	132	22,138	I	white
12	231	15,388	I	white
13	165	36,143	D	white
14	198	55,457	I	white
15	165	16,142	I	white
16	132	25,596	D	white
2144- 2.1	165	22,485	I	white
2.2	66	22,375	I	white
3	99	11,944	D	white
4	198	40,442	I	white

Continued

TABLE A.2 (Contd)

YAG-40-Shot B Particles

Particle Designation	Size, D_n (μ)	Activity at H + 300 (net well c/m)	Shape	Color
2144- 5	198	48,203	D	white
6	198	30,402	I	white
7	231	23,897	I	white
8	165	1,166	S	white
9	198	387,697	D	white
10	132	9,126	I	white
2145- 1	132	0	D	grey
2	264	76,143	D	white
3	330	56,747	D	white
4	297	81,070	D	white
5	198	46,974	I	white
6	165	25,819	I	white
7	165	47,123	I	white
8	165	4,767	I	white
9	165	20,613	I	white
10	165	38,736	I	white
11	165	23,154	S	white
12	132	15,332	I	white
13	99	20,951	I	white
14	99	47,181	I	white
15	528	197,740	D	white
2993- 4	264	41,307	I	white
5	330	126,966	I	white
7	198	9,394	I	white
8	264	55,985	I	white
9	198	9,805	D	white
10	231	21,728	D	white
11	165	28,124	D	white
2999- 1	152	14,962	I	grey
2	231	99,034	I	white
3	165	15,430	S	white
4	165	25,467	I	white

TABLE A.3

YAG-39-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2583- 1	240	27,120	S
2	145	494	S
3	120	6,973	I
4	42	307	S
5	120	3,324	I
6	60	116	I
7	120	3,823	D
8	103	165	I
9	103	281	I
10	103	120	I
11	340	5,658	I
12	103	5,292	I
13	42	460	I
14	60	1,249	I
15	30	477	I
16	60	83	I
17	84	1,128	D
18	60	5,451	I
19	30	61	S
20	42	201	I
21	30	75	S
22	30	75	I
23	223	16,402	D
24	84	2,180	D
25	42	425	I
26	30	134	S
27	30	53	I
28	42	872	D
29	120	4,436	D
30	42	33	I
31	60	850	S
32	30	0	I
33	84	51	I
34	290	34,344	I
35	30	165	I
36	60	64	I
37	42	576	I
39	84	878	I
40	103	8,322	D
41	120	8,721	D
42	60	469	S

Continued

TABLE A.3 (Contd)

YAG-39-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2583-43	84	112	I
44	60	449	I
45	84	100	I
46	60	89	I
47	170	78	I
48	84	760	D
49	103	34	D
50	30	36	I
51	21	110	S
52	60	13	I
53	84	36	D
54	30	0	S
55	30	72	I
56	84	223	I
57	21	98	S
58	30	313	S
2791- 1	84	162	D
2	42	162	I
3	60	90	I
4	120	98	D
5	170	11	D
6	120	47	D
7	84	64	D
8	42	74	I
9	120	24	D
10	60	27	D
11	60	0	I
12	30	46	I
13	30	4	I
14	84	50	I
15	42	0	I
16	84	125	I
17	120	0	D
18	60	79	D
19	60	0	D
20	60	0	D
21	15	139	S
22	30	0	I
23	42	129	D
24	15	46	I

Continued

TABLE A.3 (Contd)

YAG-39-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2791-25	42	215	I
26	30	50	I
27	42	97	D
28	42	0	I
29	21	11	I
30	51	0	I
31	30	0	I
32	60	69	I
33	15	24	S
34	15	0	S
35	21	0	S
36	30	106	S
37	42	0	S
38	30	0	D
39	60	168	D
40	84	244	D
41	30	65	I
42	30	90	S
43	42	179	I
44	60	69	D
45	30	179	I
46	120	309	D
47	60	65	I
48	30	8	I
2796- 1	84	24	I
2	30	0	I
3	42	0	I
4	42	0	S
5	42	49	D
6	42	0	I
7	60	4	I
8	42	115	I
9	42	0	I
10	42	0	I
11	42	0	I
12	84	0	D
13	60	115	D
14	42	205	D
15	42	286	I
16	42	16	I

Continued

TABLE A.3 (Contd)

YAG-39-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2796-17	42	123	I
18	21	119	S
19	60	16	S
20	84	156	I
21	84	0	D
22	84	0	I
23	103	0	D
24	60	0	D
25	30	0	S
26	120	33	D
27	60	0	D
28	42	0	I
29	30	0	I
30	60	0	I
31	60	123	D
32	84	206	I
33	42	0	I
34	60	54	I
35	60	0	D
36	60	12	D
37	42	0	I
38	60	0	I
39	42	12	D
40	30	12	S
41	21	228	S
42	21	0	I
43	120	137	I
44	60	0	D
45	60	0	D
46	84	157	D
47	84	21	D
48	30	12	I
49	84	0	I
50	42	62	I
51	84	62	D
52	84	137	I
53	30	311	S
54	60	33	I
55	120	42	I
56	84	95	I
57	42	0	I

Continued

TABLE A.3 (Contd)

YAG-39-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2796-58	30	220	S
59	30	0	I
60	84	12	I
61	84	0	I
62	42	125	I
63	84	0	I
64	60	70	I
65	42	42	I
66	60	48	I
67	60	78	D
68	21	10	S
69	84	64	D
70	60	54	D
71	84	6	I
72	30	39	I
73	30	89	I
74	84	42	I
75	60	103	D
76	42	103	I
77	84	61	I
78	60	110	D
79	60	64	I
80	30	0	S
81	60	18	I
82	30	42	I
83	103	36	I
84	42	0	I
85	60	36	D
86	30	236	S
87	60	0	I
88	84	65	D
89	60	43	D
90	30	0	I
91	51	0	I
92	103	73	I
93	42	28	I
94	21	6	S
95	42	0	I
96	42	0	D
97	42	25	I
98	60	0	D
99	30	62	I

Continued

TABLE A.3 (Contd)

YAG-39-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2796-100	60	10	D
101	42	0	D
102	60	6	D
2801- 1	84	75	I
2	84	1,188	D
3	340	76,906	I
4	60	37	I
5	84	0	D
6	42	22	D
7	30	16	S
8	30	35	I
9	42	0	I
10	60	56	I
11	84	604	I
12	120	0	D
13	84	0	D
14	30	0	I
15	30	0	I
16	42	0	I
17	30	0	I
18	42	0	I
19	120	3,913	I
20	30	0	S
21	21	77	S
22	120	8,994	I
23	30	0	I
24	170	34	I
25	84	26	D
26	42	0	I
27	42	0	I
28	60	129	I
29	42	9	I
30	42	0	I
31	30	14	I
32	60	0	D
33	42	0	D
34	84	43	I
35	60	0	D
36	60	43	D
37	42	0	I
38	30	9	I
39	15	232	S

Continued

TABLE A.3 (Contd)

YAG-39 Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2806- 1	170	15,755	D
2	120	3,201	D
3	84	35	D
4	42	182	I
5	84	17	I
6	30	9	S
7	120	299	I
8	120	317	I
9	120	0	I
10	42	0	I
11	21	0	I
12	30	0	I
13	21	0	S
14	15	0	S
15	21	0	I
16	15	61	S
2811- 1	120	1,946	I
2	120	2,898	I
3	60	126	I
4	60	73	D
5	205	15,489	D
6	120	87	I
7	60	70	I
8	145	8,300	I
9	240	19,556	I
10	30	0	I
11	42	32	I
12	170	1,274	I
13	84	40	I
14	42	53	I
15	103	1,038	I
16	30	0	I
17	120	4,370	I
18	60	84	D
19	84	5	I
20	170	0	I
21	120	739	S
22	84	982	I

Continued

TABLE A-3 (Contd)

YAG-39-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net wall c/m)	Shape
2811-23	120	67	I
24	120	1,368	I
25	120	2,345	I
26	60	0	D
27	42	0	I
28	42	44	I
29	60	908	I
30	84	1,430	I
31	120	2,465	D
32	170	6,484	I
33	120	3,767	I
34	60	568	I
35	240	1,958	I
36	84	194	D
37	120	543	I
38	84	198	I

TABLE A.4

LST-611-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2553- 1	120	590	I
2	170	6,370	D
3	170	6,240	I
4	120	11,941	I
5	120	6,617	I
6	84	4,329	D
7	42	153	I
8	30	10	S
9	42	0	I
10	84	47	I
11	42	77	S
12	30	0	I
13	60	0	S
14	21	0	I
15	42	0	I
16	84	7,909	I
17	21	101	S
18	42	118	I
19	84	87	D
20	120	6,199	I
21	120	5,867	I
22	60	118	S
23	170	11,663	I
24	205	14,078	I
25	30	0	I
26	60	0	S
27	73	128	S
28	120	1,452	I
29	170	6,539	I
30	42	44	I
31	51	0	I
32	30	81	I
33	15	0	I
34	42	0	I
35	30	212	I
36	21	134	I
37	21	0	I
38	60	302	I
39	42	81	I
40	60	0	I

Continued

TABLE A.4 (Contd)

LST-511-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2553-41	120	554	I
42	170	16,674	I
43	170	14,480	I
44	240	8,798	I
45	120	8,369	D
46	240	5,915	I
47	145	9,549	I
48	103	3,282	S
49	170	12,256	I
50	84	1,136	I
51	60	1,112	I
52	42	0	I
53	42	0	I
54	21	7	I
55	15	0	I
56	21	0	I
2576- 1	60	201	I
2	60	153	I
3	170	10,982	I
4	21	143	I
5	42	75	I
6	84	41	I
7	21	105	S
8	30	75	I
9	60	0	I
10	145	0	D
11	42	156	I
12	21	0	S
13	15	34	I
14	60	0	S
15	60	85	I
16	21	0	S
17	42	0	I
18	30	75	I
19	42	0	S
20	60	117	I
21	30	77	I
22	15	0	S
23	21	127	S
24	15	0	S

Continued

TABLE A.4 (Contd)

LST-611-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2576-25	42	33	I
26.1	42	10	I
26.2	42	0	I
28	21	0	I
29	15	0	I
30	30	0	I
31	30	0	I
32	30	0	I
33	84	0	I
34	21	101	I
35	170	0	D
36	170	1,727	D
37	170	0	I
38	60	0	D
39	42	101	I
40	42	207	I
41	21	54	I
42	21	89	S
43	15	125	I
44	21	161	S
45	42	143	I
46	30	107	I
47	60	0	I
48	21	0	S
49	30	11	I
50	30	71	I
51	30	46	I
52	21	64	I
2578- 1	170	17,207	D
2	60	0	I
3	170	4,712	I
4	42	29	S
5	15	125	S
6	30	36	I
7	240	39,681	I
8	120	2,535	I
9	170	17,640	I
10	15	19	S
11	15	38	S
12	170	15,267	I

Continued

TABLE A.4 (Contd)

LST-611-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2578-13	240	14,280	D
14	170	38	D
15	30	50	I
16	30	0	I
17	170	7,849	I
18	42	88	I
19	42	210	I
20	170	16,821	I
21	30	88	I
22	21	76	I
23	21	145	I
24	15	19	I
25	60	57	D
26	30	0	I
27	21	0	S
28	42	38	I
29	15	115	S
30	21	0	S
31	21	115	I
32	15	0	I
2581- 1	205	0	I
2	120	11	D
3	60	19	I
4	42	134	I
5	42	0	I
6	84	267	I
7	60	69	I
8	60	0	I
9	60	19	I
10	42	57	I
11	42	172	I
12	84	19	D
13	60	0	I
14	30	0	I
15	60	0	I
16	120	0	D
17	60	88	I
18	42	0	I
19	60	96	I
20	120	0	D

Continued

TABLE A.4 (Contd)

LST-611-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2581-21	120	0	D
22	84	0	D
23	42	0	D
24	60	0	I
25	15	0	S
26	42	0	I
27	21	0	I
28	30	0	I
29	30	0	I
30	73	198	I
31	21	0	I
32	42	343	D

TABLE A.5

YFNB-13-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
1974- 1	120	459	I
2	120	0	S
3	30	63	I
4	42	112	I
5	60	77	I
6	30	122	I
7	60	15	I
8	60	73	I
9	21	25	S
10	21	35	I
11	30	0	I
12	21	19	I
13	30	162	I
14	21	97	I
15	42	58	I
16	60	251	I
17	84	125	I
18	21	0	I
19	680	0	S
20	15	0	S
21	30	146	S
22	240	0	D
23	21	0	I
24	21	0	I
25	21	35	I
26	30	0	I
27	15	87	I
28	42	200	I
29	30	87	I
30	60	58	I
31	30	78	S
32	84	97	I
33	84	58	I
34	42	132	I
35	120	144	I
36	120	78	I
37	60	74	I
38	42	45	S
39	30	78	S
40	60	0	I
41	42	143	I

Continued

TABLE A.5 (Contd)

YFUB-13-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
1974-42	30	157	I
43	60	152	I
44	42	7	I
45	30	121	I
46	30	230	I
47	30	0	I
48	30	0	I
49	60	0	I
50	30	0	I
51	30	24	S
52	30	7	S
53	30	0	S
54	21	24	S
55	30	0	S
56	30	48	I
57	42	0	I
58	30	168	I
59	42	0	I
60	30	0	S
61	60	167	D
62	21	52	I
63	42	35	I
64	30	91	I
65	30	52	S
66	30	73	S
67	42	47	I
68	30	91	S
69	42	13	I
70	30	99	S
71	30	73	I
72	30	21	I
73	21	183	S
74	30	399	S
75	21	0	I
76	30	0	I
77	42	0	D
78	15	0	S
79	21	105	I
80	30	56	I
81	30	86	I

Continued

TABLE A.5 (Contd)

YFNB-13-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
1974-82	21	0	I
83	30	34	I
84	30	0	I
85	21	0	I
86	30	0	I
87	30	144	I
88	30	0	I
89	30	0	I
90	30	26	I
91	30	0	I
92	21	144	I
93	21	13	I
94	30	13	S
95	30	0	I
96	60	132	D
97	15	105	S
1977- 1	480	984,805	I
2	480	792,378	I
3	145	78	I
4	120	125	I
5	120	157	I
6	60	117	I
7	30	21	S
8	42	0	S
9	42	21	I
10	120	0	D
11	30	0	I
12	21	117	I
13	30	0	I
14	84	0	D
15	30	117	I
16	84	83	I
17	42	167	I
18	193	0	I
19	73	83	I
20	60	1,225	I
21	42	233	I
22	42	200	I
23	30	0	I

Continued

TABLE A.5 (Contd)

YFNB-13-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
1974-82	21	0	I
83	30	34	I
84	30	0	I
85	21	0	I
86	30	0	I
87	30	144	I
88	30	0	I
89	30	0	I
90	30	26	I
91	30	0	I
92	21	144	I
93	21	13	I
94	30	13	S
95	30	0	I
96	60	132	D
97	15	105	S
1977- 1	480	984,805	I
2	480	792,378	I
3	145	78	I
4	120	125	I
5	120	157	I
6	60	117	I
7	30	21	S
8	42	0	S
9	42	21	I
10	120	0	D
11	30	0	I
12	21	117	I
13	30	0	I
14	84	0	D
15	30	117	I
16	84	83	I
17	42	167	I
18	103	0	I
19	73	83	I
20	60	1,225	I
21	42	233	I
22	42	200	I
23	30	0	I

Continued

TABLE A.5 (Contd)

YFNB-13-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
1977-24	120	2,424	D
25	120	2,231	D
26	170	7,126	D
27	42	193	I
28	42	310	I
29	60	27	I
30	60	176	I
31	42	356	I
32	84	1,166	D
33	30	0	I
34	60	0	I
35	84	0	I
36	42	0	I
37	30	0	S
38	120	0	D
39	60	43	D
40	15	250	S
41	21	77	I
42	21	33	S
43	42	0	I
44	42	226	I
45	42	93	I
46	42	0	I
47	60	20	D
48	42	83	I
49	42	90	I
50	30	57	I
51	60	100	I
52	30	0	I
53	30	0	I
54	21	30	I
55	21	57	I
56	30	40	I

TABLE A.6

YFNB-29-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
1373- 2	480	47,958	S
3	480	71,445	S
4	580	72,781	I
5	240	21,240	S
6	480	31,486	I
7	240	6,590	I
8	120	3,111	S
9	205	7,352	I
10	240	9,463	D
11	290	3,614	I
12	120	1,040	D
13	120	4,135	I
14	240	388	D
15	240	5,781	I
16	170	2,620	I
17	120	811	S
18	120	785	I
19	120	254	S
20	170	1,437	D
21	170	3,405	D
1377- 1	340	43,991	I
2	170	245	I
3	410	221,893	S
4	410	383,104	I
5	480	87,364	I
6	84	527	S
7	120	149	I
8	120	6,716	D
9	84	448	I
10	170	66	I
11	170	136	I
1381- 1	480	389,485	I
2	290	234,906	I
3	480	174,877	I
4	340	61,653	S
5	580	184,800	I
6	120	3,191	D
7	680	489,310	I
8	680	289,267	I

Continued

TABLE A.6 (Contd)

YFNB-29-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
1381- 9	340	619,448	D
10	580	169,124	D
1385- 1	290	44,298	D
2	84	95	I
3	340	166,440	I
4	290	212,502	I
5	580	354,613	D
6	170	15,622	D
7	60	1,407	I
8	103	293	I
9	120	6,880	I
10	60	756	I
11	120	348	D
12	410	8,467	I
13	60	395,842	I
14	120	7,801	I
15	30	0	I
16	60	966	D
17	60	1,811	I
18	60	729	D
19	60	1,082	D
20	84	813	I
21	170	3,698	D
22	205	0	D
23	410	6,204	D
24	60	0	I
25	84	0	I
26	30	0	I
27	30	0	I
28	21	0	S
29	15	40	S
30	60	979	D
31	42	84	D
32	15	73	S
33	21	29	S
34	42	0	I
35	120	1,625	D
36	60	1,780	I
37	60	250	D
38	42	184	I

Continued

TABLE A.6 (Contd)

YFNB-29-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
1385-39	145	7,612	I
40	42	239	I
41	84	5,554	I
42	30	251	I
43	30	0	I
44	60	1,269	I
45	84	1,556	D
46	21	36	I
1389- 1	340	58,839	I
2	580	50,641	I
3	410	63,854	I
4	410	1,698,631	I
5	30	0	I
6	15	119	I
7	21	152	I
8	84	1,560	I
9	60	1,003	I
10	170	169	D
11	30	54	I
12	60	65	I
13	30	87	I
14	60	119	D
15	21	39	S
16	42	282	D
17	205	5,068	D
18	21	152	I
19	42	43	I
20	42	0	I
21	15	121	S
22	42	0	D
1392- 1	410	142,176	I
2	145	83,316	I
3	42	0	I
4	15	506	I
5	30	60	S
6	30	610	I
7	15	0	I
8	15	0	I

Continued

TABLE A.6 (Contd)

YFNB-29-Shot B Particles

Particle Designation	Size, D_e (μ)	Activity at H + 300 (net well c/m)	Shape
1392- 9	103	90	I
10	60	0	I
11	15	0	I
12	15	218	I
13	15	57	I
14	30	0	I
15	21	28	I
16	30	44	I
17	15	126	S
18	21	0	I
19	42	0	I
20	21	39	I
21	15	39	I
22	42	534	I
23	21	0	I
24	42	28	I
25	30	0	S
26	84	0	I
27	15	7	S
28	42	65	I
29	60	0	I
30	30	0	I
31	21	76	S
32	84	23	I
33	15	148	S
2293- 1	120	296	S
2	60	167	I
3	42	9	I
4	170	0	D
5	21	70	S
6	21	79	I
7	42	62	I
8	60	67	I
9	84	85	D
10	30	35	I
11	30	132	S
12	42	93	I
13	21	19	S
14	21	146	I
15	21	58	I

Continued

TABLE A.6 (Contd)

YFNB-29-Shot B Particles

Particle Designation	Size, D_a (μ)	Activity at H + 300 (net well c/m)	Shape
2293-16	30	0	I
17	60	9	S
18	60	44	I
19	60	0	I
20	42	9	I
21	42	115	I
22	84	88	D
23	42	106	I
24	30	26	I
25	21	48	I
26	21	6	I
27	21	93	S

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